

LEVEL 4 ASSESSMENT SPECIFICATION

Student name:	Matthew Thomas	Student ID number:	81655
Programme:	HNC Process Operations Engineering		
Module:	Industrial Process Operations and Control		
Module code:	PCPO4004	Contribution to Overall Module Assessment (%):	50%
Lecturer:	Adam Jenkins	Internal Verifier:	Lance Rutherford
Assignment Title:	Process Automation	Word count (or equivalent):	2000
Submission deadline:	06/05/2020	Return date of provisional marks & written feedback:	27/05/2020
Submission method:	All written assessments, where practical and possible, must be submitted via Turnitin unless otherwise instructed by the Lecturer. (Please DO NOT put this assessment specification into Turnitin or it will match many similarities with other students' submissions.) Alternative submission method (if applicable): Late submission of the assessment will result in a late penalty mark. Penalties for late submission: Up to one week late, maximum mark of 40%. Over one week late, 0%. Only the Extenuating Circumstances Panel may approve a change to submission dates.		
Academic honesty / referencing:	Academic honesty is required. In the main body of your submission you must give credit to authors on whose research and ideas your work is based. Append to your submission a reference list that indicates the books, articles, etc. that you have used, cited or quoted in order to complete this assessment.		

Module Learning Outcomes (from module syllabus)

LO1, LO2, LO3.

Learner Name : Matthew Thomas.

Course : HNC Process Operations Engineering, Year 1.

Module Code : PCPO4004.

Module Name : Industrial Process Operations and Control.

Assignment : Process Automation

Contents Page

Section	Page
Contents Page	2
Introduction	3
Task 1 : Duty / Standby Pumping Operation	4
Contents Page	5
Introduction	6
Duty / Standby Pump Switch Over SOP	7
Emergency Shutdown SOP	12
Task 2 : Steam Generation Plant Operation	17
Contents Page	18
Introduction	19
Overview of Boiler System	20
Boiler Start-Up SOP	22
Timing Diagram	37
Alarm and Interlock Matrix	38
References	39
Task 3 : Bottle Filling Plant	40
Contents Page	41
Introduction	42
Overview of Bottling Plant Process	43
Bottling Plant Process Flow Diagram	45
Task 4 : SCADA (Supervisory Control and Data Acquisition)	46
Contents Page	47
Introduction	48
SCADA Report	49
References	50

Introduction

In this assignment, four pieces of work shall be completed.

The first shall be a SOP for the switch over between two pumps on a Water System. This will also include a Shutdown Procedure to be used in Emergency situations.

The second will be an Overview of a Boiler Plant. Included in this section is a SOP for starting the Boiler.

The third part will be an Overview of a Bottling Plant Operation. Also in this section will be a Process Flow Diagram for this Plant.

Finally the fourth section will give a brief overview of a SCADA System.

Learner Name : Matthew Thomas.

Course : HNC Process Operations Engineering, Year 1.

Module Code : PCPO4004.

Module Name : Industrial Process Operations and Control.

Task 1 : Duty / Standby Pumping Operation

Contents Page

Section	Page
Task 1 : Duty / Standby Pumping Operation	4
Contents Page	5
Introduction	6
Duty / Standby Pump Switch Over SOP	7
Emergency Shutdown SOP	12

Introduction

In this section of the Assignment, two pieces of work shall be completed.

The first is the creation of a SOP (Standard Operating Procedure) for the Switch Over between a Duty and Standby Pump on a Water System.

The second is the creation of a SOP for the Emergency Shutdown of the same Water System.

Duty / Standby Pump Switch Over SOP

(Begins on Next Page)



Switch Over between V_101 Flow Pumps

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Issue Date:	28-02-2020
Issuer:	M.Thomas
Authorised By:	N.Roberts
Location:	Haverfordwest
Document Type:	SOP

SCOPE

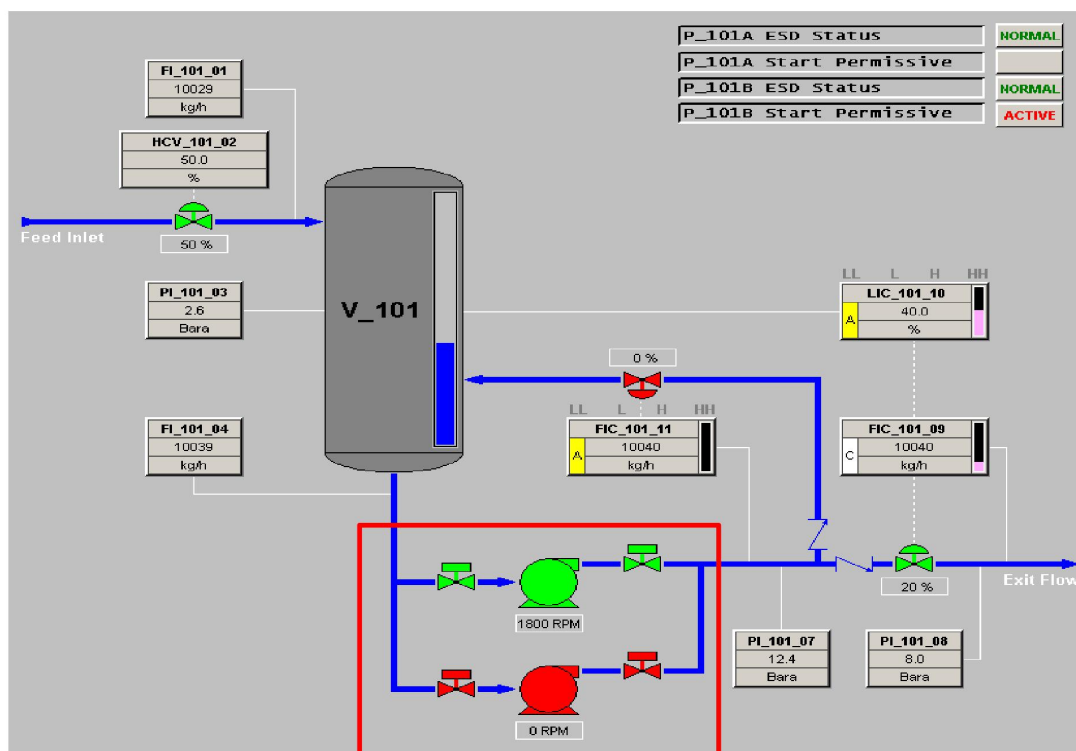
To ensure safe switch over between V_101 Flow Pumps (P_101A and P_101B) whilst maintaining standard operating flow levels

RESPONSIBILITIES

JOB TITLE	RESPONSIBILITIES
Shift Manager	➤ accountable for procedural enforcement and correct actions
Plant Operator	➤ to apply the procedural intent

PROCEDURE

The below is a Screenshot of the site SCADA for Pumping System V101. For the following Procedures only the highlighted Area will be used. Screenshots will only show this area.





Switch Over between V_101 Flow Pumps

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- Switch between Pump P_101A and P_101B on Water Tank V_101

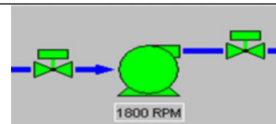
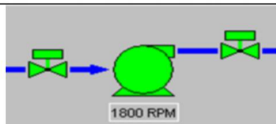
Step	SCADA at Start	SCADA at End
Open Inlet Valve on Pump P_101B by clicking on highlighted Valve on the SCADA and selecting "Open" in Valve Menu.		
Turn on Pump P_101B by clicking on the highlighted pump on the SCADA and selecting "On" in the Pump Menu.		
When Pump P_101B reached 1,800rpm open Outlet Valve by clicking on highlighted Valve on the SCADA and selecting "Open" in Valve Menu.		
Shut Inlet Valve on Pump P_101A by clicking on highlighted Valve on the SCADA and selecting "Close" in Valve Menu.		
Turn off Pump P_101A by clicking on the highlighted pump on the SCADA and selecting "Off" in the Pump Menu.		
When Pump P_101A reached 0rpm Close Outlet Valve by clicking on highlighted Valve on the SCADA and selecting "Close" in Valve Menu.		





Switch Over between V_101 Flow Pumps

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- Switch between Pump P_101B and P_101A on Water Tank V_101

Step	SCADA at Start	SCADA at End
Open Inlet Valve on Pump P_101A by clicking on highlighted Valve on the SCADA and selecting "Open" in Valve Menu.		
Turn on Pump P_101A by clicking on the highlighted pump on the SCADA and selecting "On" in the Pump Menu.		
When Pump P_101A reached 1,800rpm open Outlet Valve by clicking on highlighted Valve on the SCADA and selecting "Open" in Valve Menu.		
Shut Inlet Valve on Pump P_101B by clicking on highlighted Valve on the SCADA and selecting "Close" in Valve Menu.		
Turn off Pump P_101B by clicking on the highlighted pump on the SCADA and selecting "Off" in the Pump Menu.		

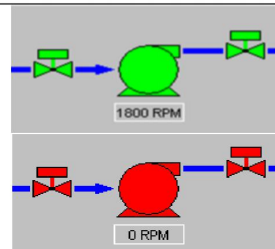
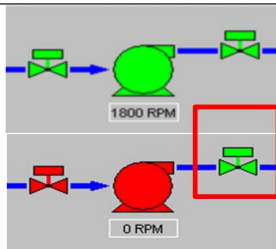




Switch Over between V_101 Flow Pumps

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When Pump P_101B reached 0rpm
Close Outlet Valve by clicking on
highlighted Valve on the SCADA and
selecting "Close" in Valve Menu.



REFERENCE OR RELATED DOCUMENTS

H-SOP-ENG-002 : Emergency Shutdown of V_101 System

TRAINING REQUIRED

HISTORY OF AMENDMENTS

Version No.	Page/s	Section	Amendment Details	Amended By	Date

Emergency Shutdown SOP

(Begins on Next Page)



Emergency Shutdown of V_101 System

Document Number:	H-SOP-ENG-002
Version Number:	1
Issue Date:	28-02-2020
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Location:	Haverfordwest
Document Type:	SOP

SCOPE

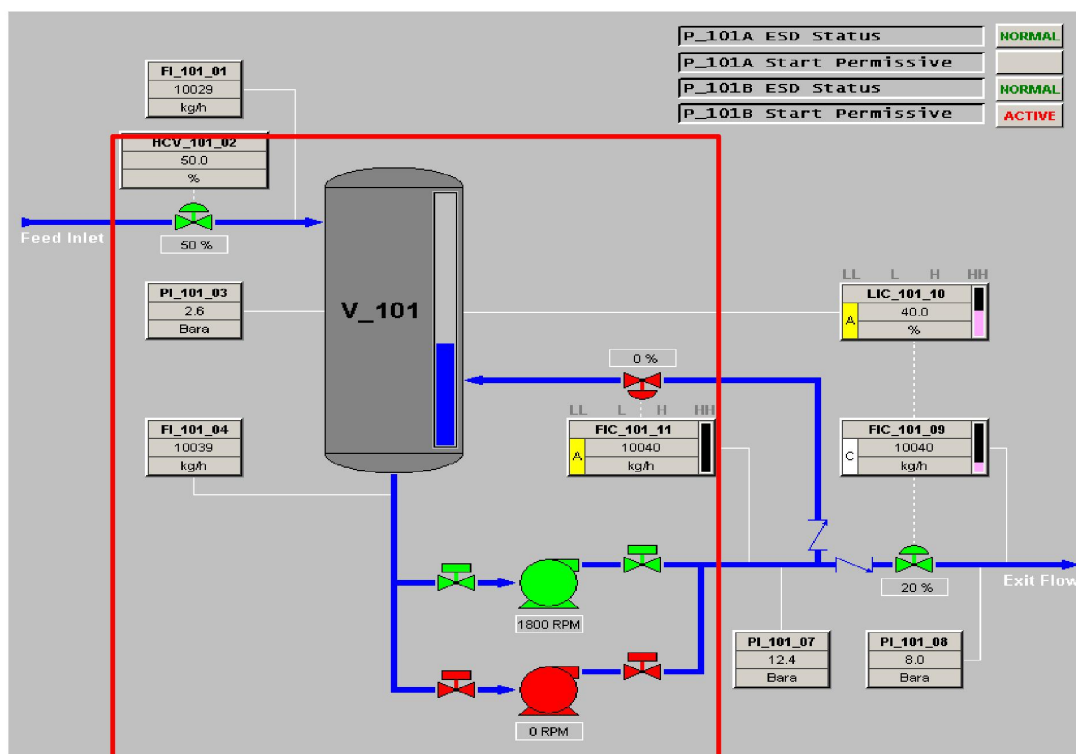
To ensure safe switch Shutdown of V_101 System

RESPONSIBILITIES

JOB TITLE	RESPONSIBILITIES
Shift Manager	➤ accountable for procedural enforcement and correct actions
Plant Operator	➤ to apply the procedural intent

PROCEDURE

The below is a Screenshot of the site SCADA for Pumping System V101. For the following Procedure only the highlighted Area will be used. Screenshots will only show this area.





Emergency Shutdown of V_101 System

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Document Type:	SOP

- Emergency Shutdown of V_101 System when running on Pump P_101A

Step	SCADA at Start	SCADA at End
Shut off Supply Valve to Vessel V_101 by clicking on highlighted Valve on the SCADA and selecting "0" in the Flow Box on Valve Menu.		
Shut Inlet Valve on Pump P_101A by clicking on highlighted Valve on the SCADA and selecting "Close" in Valve Menu.		
Turn off Pump P_101A by clicking on the highlighted pump on the SCADA and selecting "Off" in the Pump Menu.		
When Pump P_101A reached 0rpm Close Outlet Valve by clicking on highlighted Valve on the SCADA and selecting "Close" in Valve Menu.		

- Emergency Shutdown of V_101 System when running on Pump P_101B

Step	SCADA at Start	SCADA at End
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Emergency Shutdown of V_101 System

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Shut off Supply Valve to Vessel V_101 by clicking on highlighted Valve on the SCADA and selecting "0" in the Flow Box on Valve Menu.		
Shut Inlet Valve on Pump P_101B by clicking on highlighted Valve on the SCADA and selecting "Close" in Valve Menu.		
Turn off Pump P_101B by clicking on the highlighted pump on the SCADA and selecting "Off" in the Pump Menu.		
When Pump P_101B reached 0rpm Close Outlet Valve by clicking on highlighted Valve on the SCADA and selecting "Close" in Valve Menu.		



REFERENCE OR RELATED DOCUMENTS

TRAINING REQUIRED

HISTORY OF AMENDMENTS

Version	Page/s	Section	Amendment Details	Amended By	Date
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Document : H-SOP-ENG-002
Title : Emergency Shutdown of V_101 System

Page 3 of 4

	Emergency Shutdown of V_101 System	Document Number:	H-SOP-ENG-002
		Version Number:	1
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No.					

Learner Name : Matthew Thomas.

Course : HNC Process Operations Engineering, Year 1.

Module Code : PCPO4004.

Module Name : Industrial Process Operations and Control.

Task 2 : Steam Generation Plant Operation

Contents Page

Section	Page
Task 2 : Steam Generation Plant Operation	17
Contents Page	18
Introduction	19
Overview of Boiler System	20
Boiler Start-Up SOP	22
Timing Diagram	37
Alarm and Interlock Matrix	38
References	39

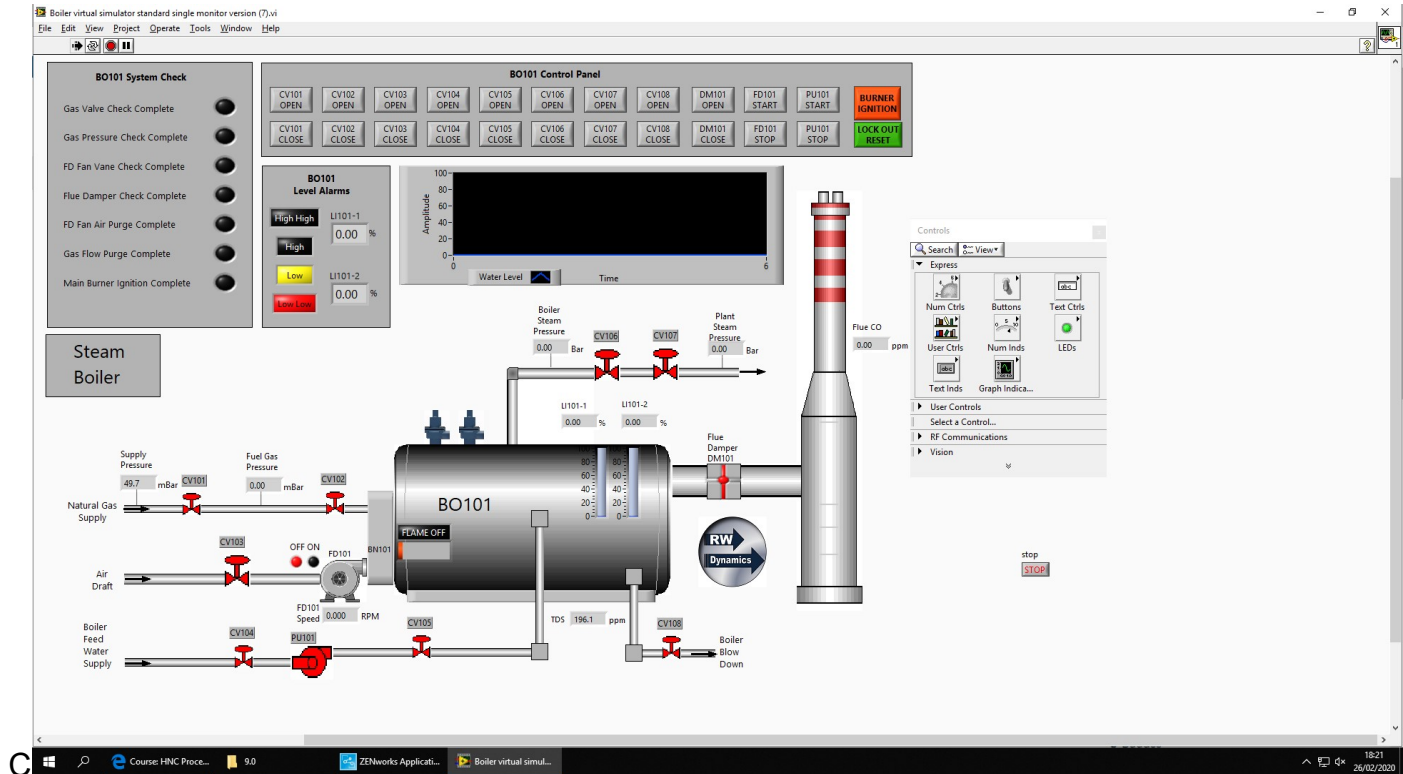
Introduction

This section of the Assignment will cover the Operation of a Boiler Plant. It will give a brief overview of the Plant followed by a SOP for the start-up of the Plant.

There will also be a Timing Diagram for the Start Up and an Alarm and Interlock Matrix.

Overview of Boiler Plant

Below is a Screenshot of Boiler Plant, BO101.



This system is made up of :

A Boiler, labelled as BO101. This is the Vessel in which Steam will be produced. This is done by heating water within the Vessel. Also on this Vessel are 2 Pressure Relief Valves and a pair of Sight Glasses. The Pressure Relief Valves are installed and set to lift if the Pressure of the Steam Boiler becomes too high. This is a safety feature and done to insure that the chances of a Boiler Vessel exploding are as low as possible. The Sight Glasses are intended to show the Water Level of the Boiler. As the Water within the Boiler is very rarely still, having 2 Sight Glasses gives a better indication of the Level of the Water. It is also a Backup should 1 fail.

A Burner, labelled as FD101. This is the unit that heats the Water within the Boiler. To be able to do this, the Burner needs a supply of Fuel and Oxygen. The Fuel in this System is Natural Gas and is delivered via the Natural Gas Supply Line which consists of 2 Valves (CV101 and CV102) and 2 Pressure Gauges. The Oxygen is provided from the Air Draft Line, which has a Valve, labelled CV103 on it.

A Water Feed Line, consisting of 2 Valves (CV104 and CV105) and a Delivery Pump, labelled as PU101. This line delivers the Water to the Boiler which is heated and turned into Steam. This line will start and stop deliveries based on the Water Level within the Boiler. When the Boiler has enough Water, this line will stop, but as soon as the Water Level drops, the line will begin to deliver Water again.

A Boiler Blowdown Line, with a single Valve, labelled as CV108. This line is used to remove Water from the Boiler. As Steam is generated within the Boiler, any impurities within the Water are not removed and

so begin to concentrate within the Water in the Boiler. These impurities are called the Total Dissolved Solids, or TDS, and will over time begin to cause foam to build up within the Boiler on top of the Water. This will stop the Steam from leaving the Boiler and resulting in Steam Outage for the Factory. To prevent this build up, when the TDS levels begin to climb, a blowdown of the Boiler is completed. This removes some of the impure Water within the Boiler and allows new water to enter into the Boiler via the Water Feed Line.

A Flue Line, with a Damper Valve, labelled as DM101. This line allows waste gases to exit the Burner and Boiler. They enter into a Flue (sometimes a stack or chimney) and then exits into the atmosphere. A Steam Line where Steam leaves the Boiler to be used across Site. This Steam Line has a Crown Valve and an Isolation Valve (CV106 and CV107) and 2 Pressure Gauges.

The Plant works by having Water delivered into the Boiler, which is then heated by the Burner as it burns Natural Gas. As this Water heats, Steam is generated which leaves the Boiler at the top through the Crown and Isolation Valves and travels into the Site Steam Pipework System for distribution. Two Waste Products are produced during this Process. The first are Waste Gases which escape into the Flue and are released to Atmosphere. The second is water concentrated with impurities, which is removed to drain via a Blowdown when the level gets too high.



Boiler Start-Up SOP

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Start Up Procedure of BO101 Steam Boiler Plant

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SCOPE

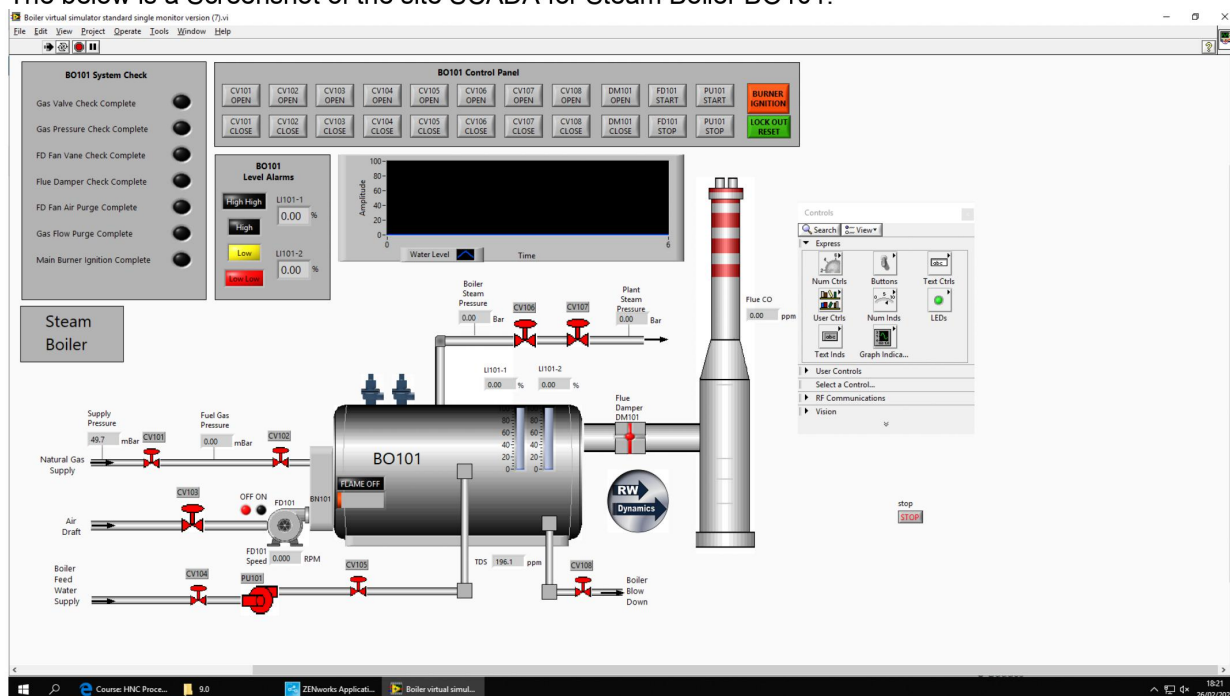
To ensure safe start-up of BO101 Steam Boiler Plant

RESPONSIBILITIES

JOB TITLE	RESPONSIBILITIES
Shift Manager	➤ accountable for procedural enforcement and correct actions
Plant Operator	➤ to apply the procedural intent

PROCEDURE

The below is a Screenshot of the site SCADA for Steam Boiler BO101.



- Start-up of Steam Boiler Plant BO101.

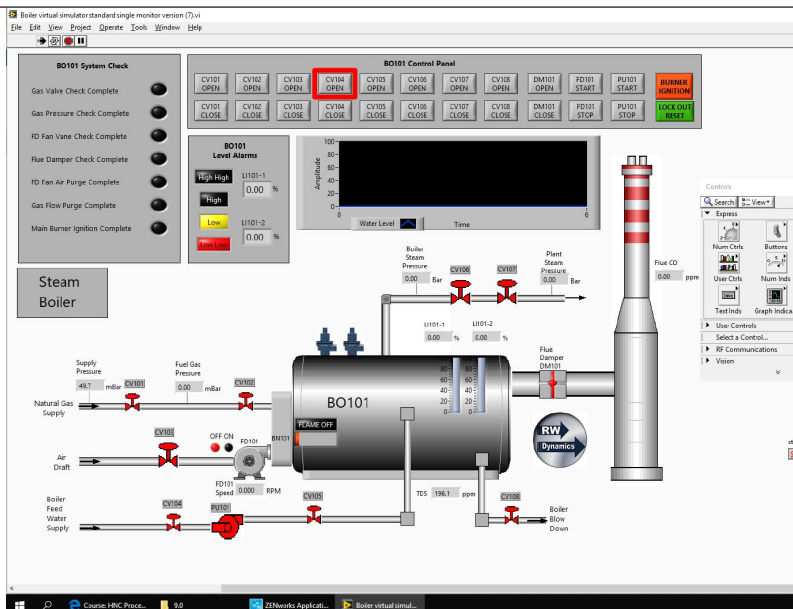
Step	SCADA Screenshot
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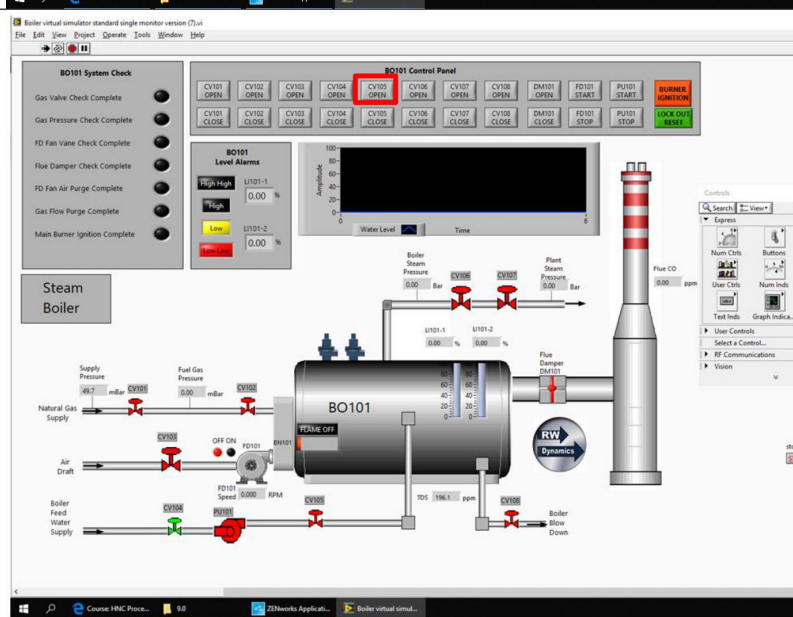
Start Up Procedure of BO101 Steam Boiler Plant

Document Number:	H-SOP-ENG-003
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Open Boiler Feed Water Supply Inlet Valve (CV104) by clicking the Highlighted Button "CV104 Open"



Open Boiler Feed Water Supply Outlet Valve (CV105) by clicking the Highlighted Button "CV105 Open"

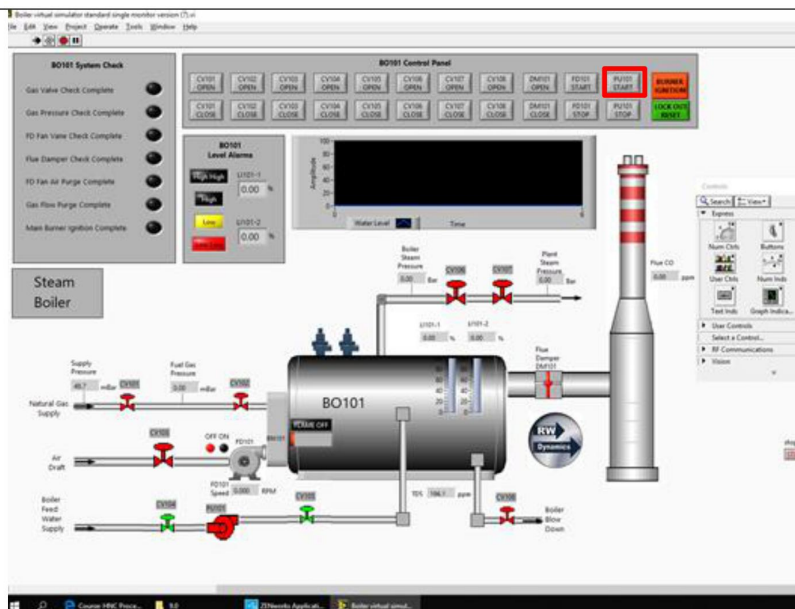




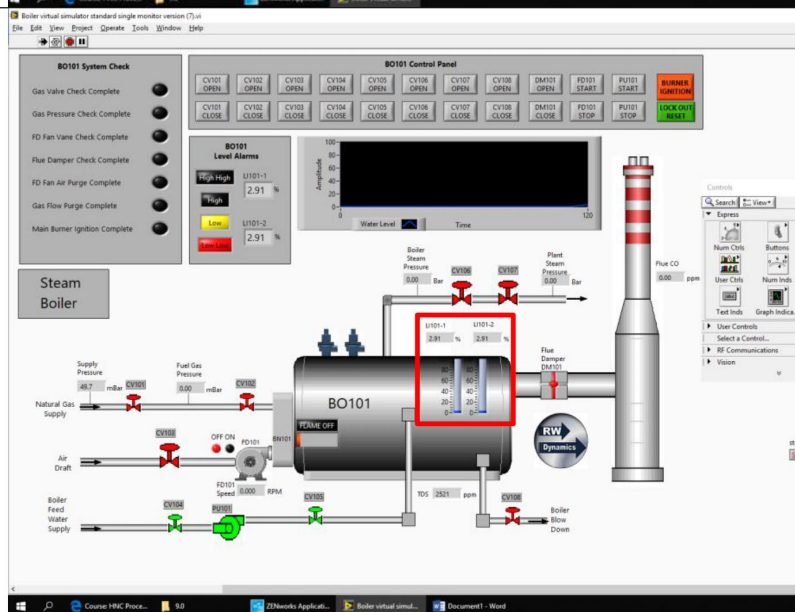
Start Up Procedure of BO101 Steam Boiler Plant

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Run Boiler Feed Water Pump (PU101) but clicking the Highlighted Button "PU101 Start"



Let the Boiler BO101 fill to 35% Water. This will be indicated on the SCADA Sight Glasses (Highlighted)

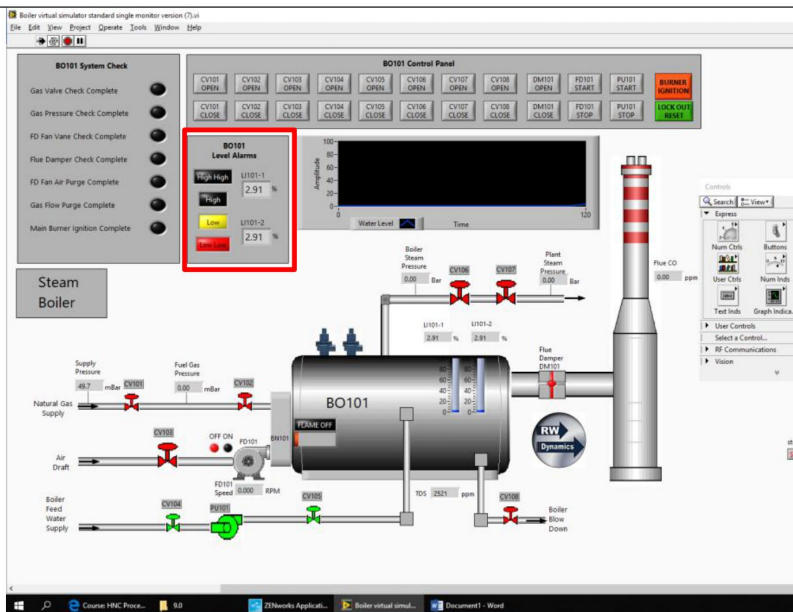




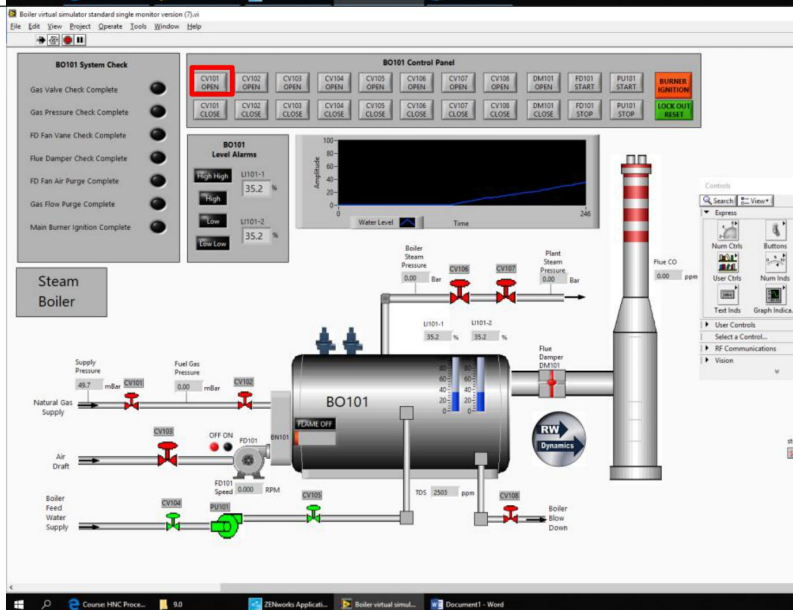
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Once Boiler is 35% full of Water, the "Low Low" and "Low" Level Alarms will deactivate.



Open Natural Gas Supply Inlet Valve (CV101) by clicking the Highlighted Button "CV101 Open"

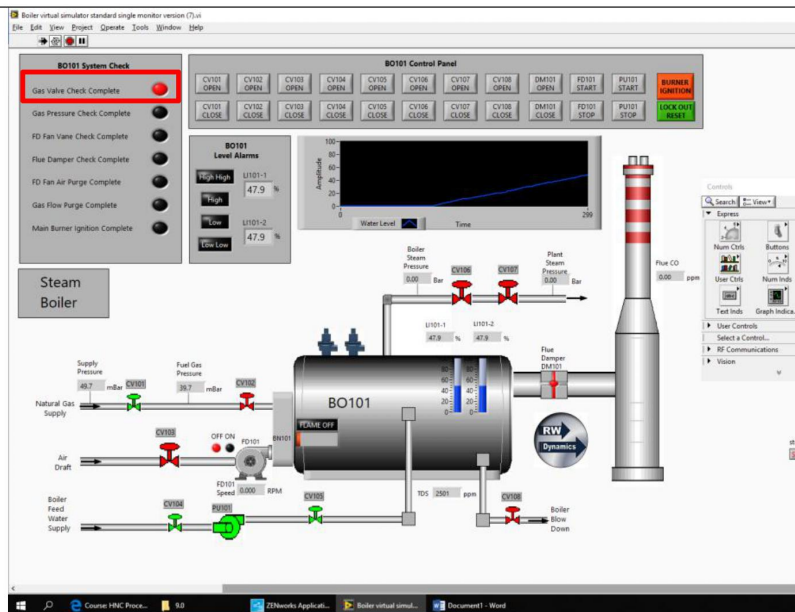




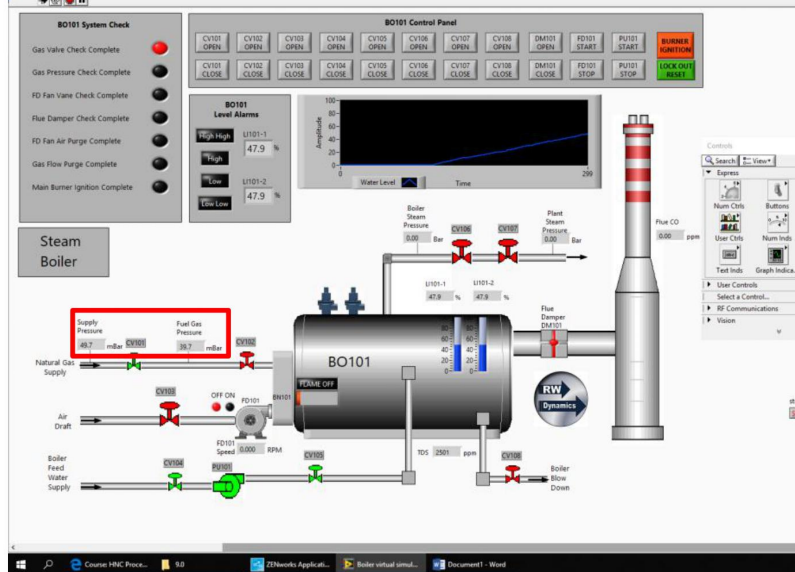
Start Up Procedure of BO101 Steam Boiler Plant

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Doing this will complete the “Gas Valve Check” for the System Checks (Highlighted).



Let Supply Pressure and Fuel Gas Pressure match and stabilise as shown on the SCADA Pressure Gauges (Highlighted). Doing this will complete the “Gas Valve Check” for the System Checks.

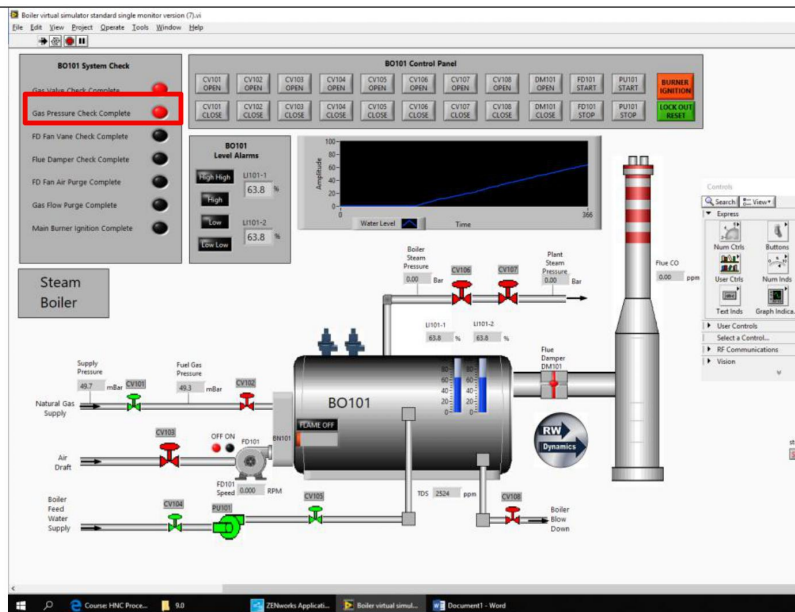




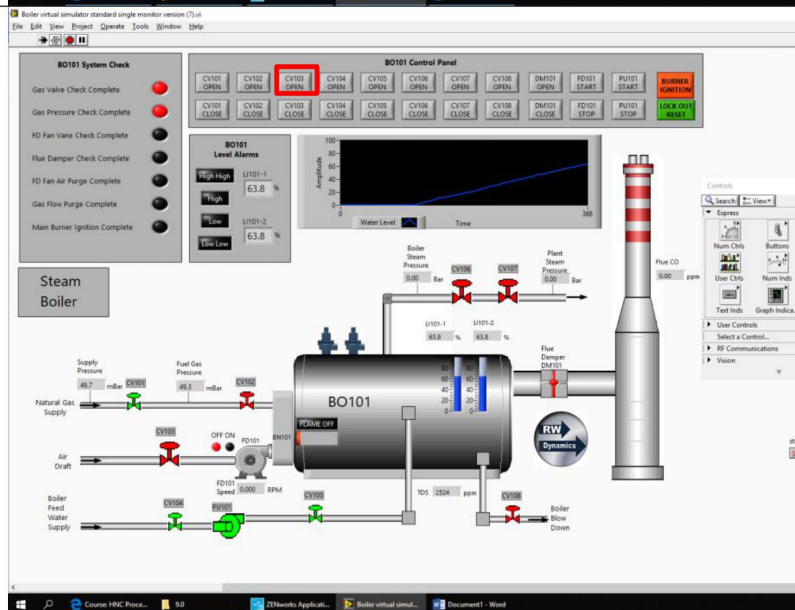
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Doing this will complete the “Gas Pressure Check” for the System Checks (Highlighted).



Once stabilised, open Air Draft Supply Valve (CV103) by clicking the Highlighted Button “CV103 Open”

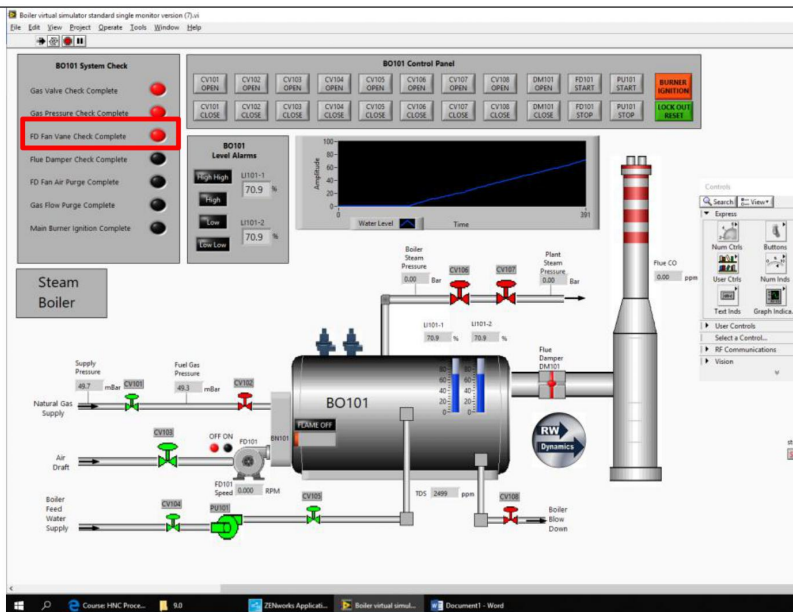




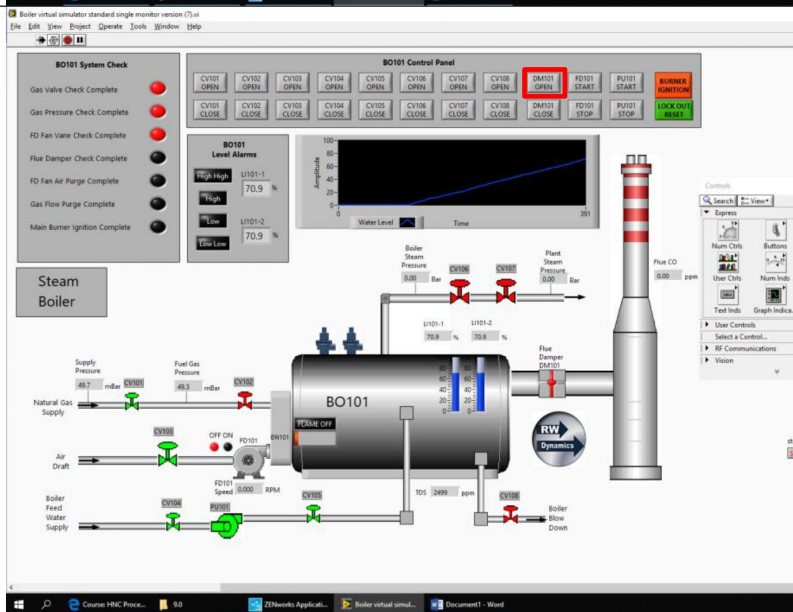
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Doing this will complete the “FD Fan Vane Check” for the System Checks (Highlighted).



Open Flue Damper Valve (DM101) by clicking the Highlighted Button “DM101 Open”

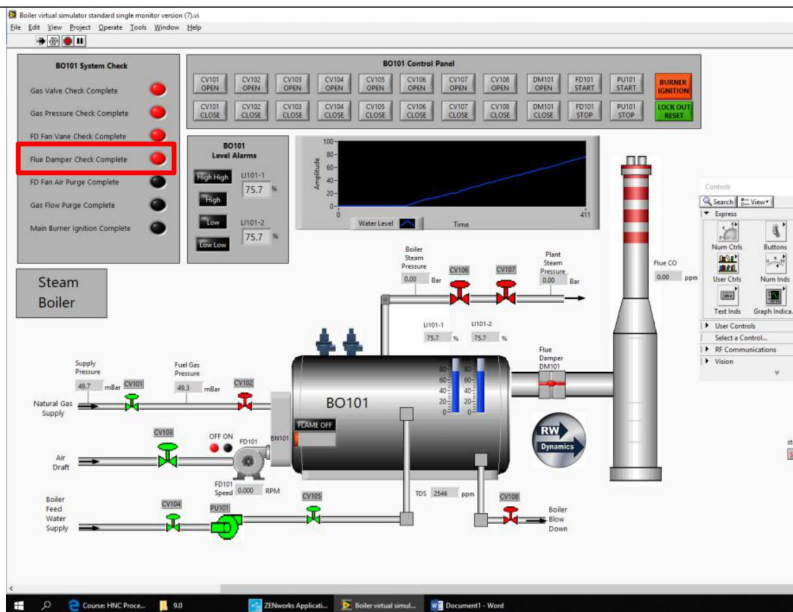




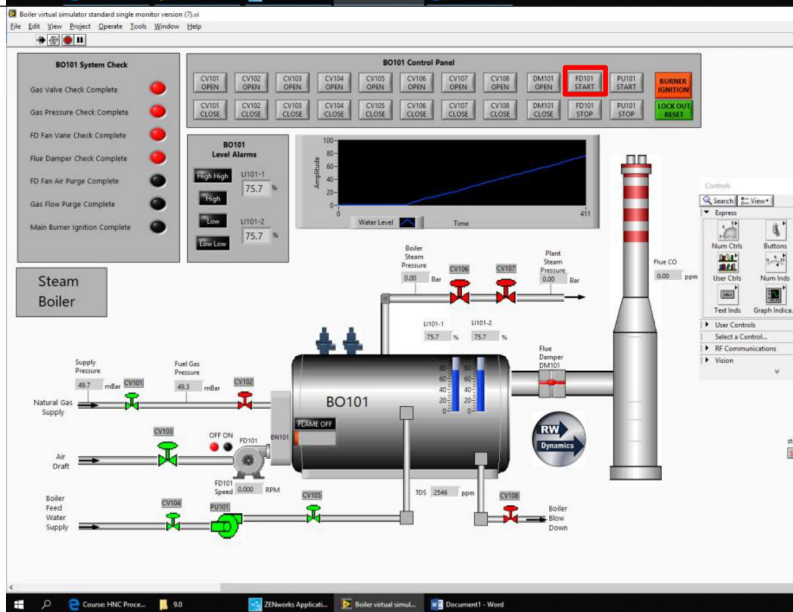
Start Up Procedure of BO101 Steam Boiler Plant

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Doing this will complete the “Flue Damper Check” for the System Checks (Highlighted).



Run Boiler Burner (FD101) by clicking the Highlighted Button “FD101 Start”

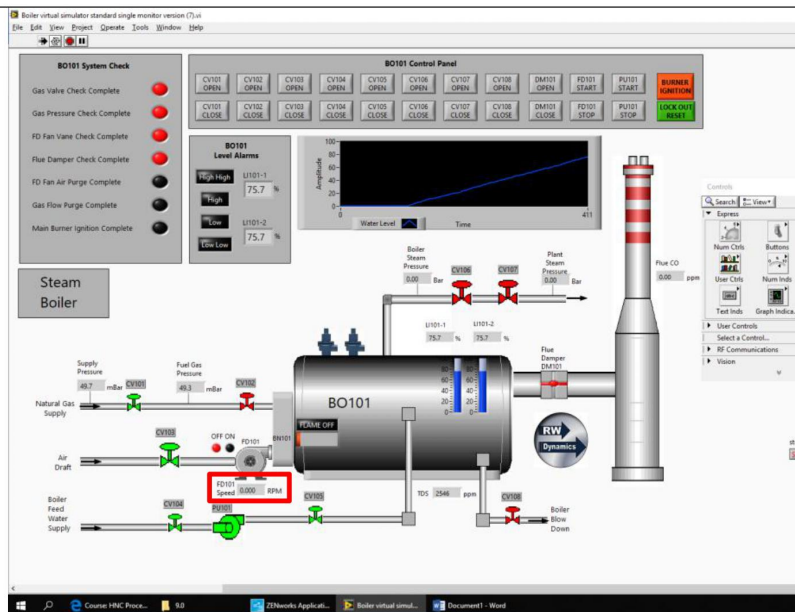




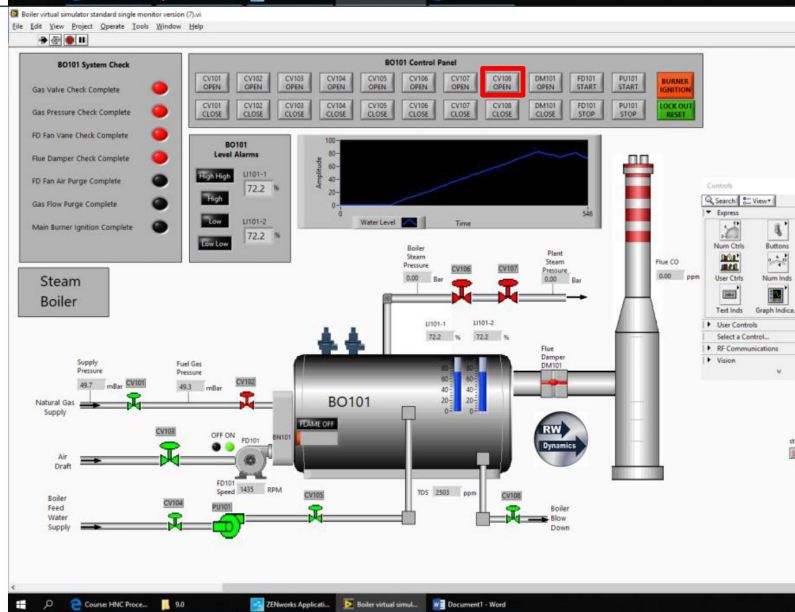
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Let the Burner run up to 1,440rpm as indicated on the SCADA (Highlighted)



Open Boiler Blow Down Valve (CV108) by clicking the Highlighted Button "CV108 Open"

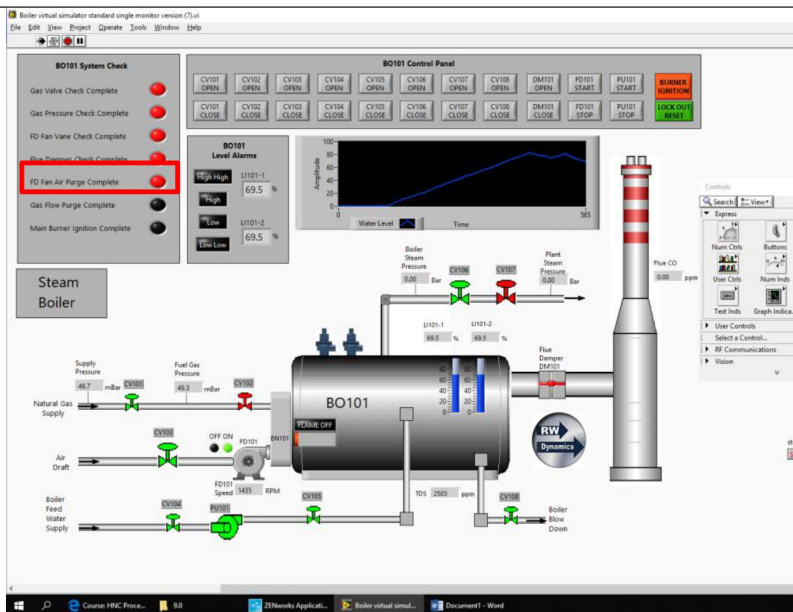




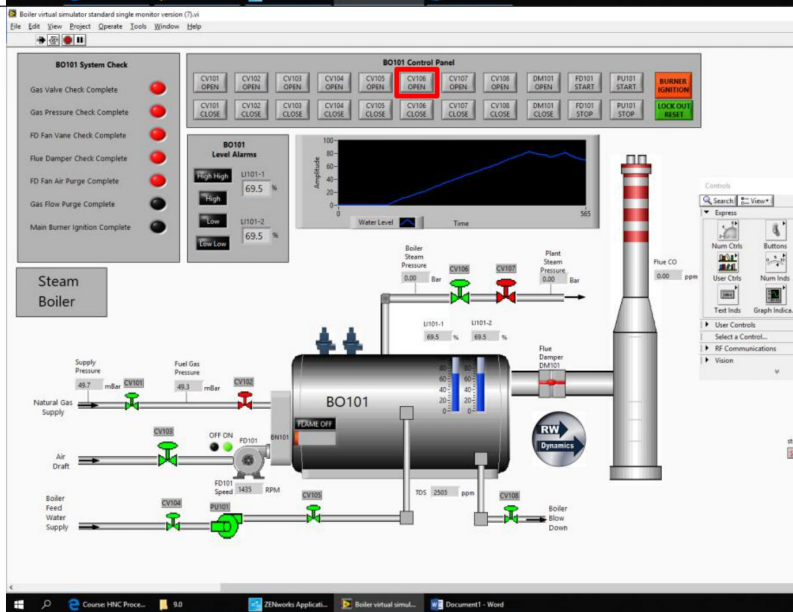
Start Up Procedure of BO101 Steam Boiler Plant

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Doing this will complete the “FD Fan Air Purge” for the System Checks (Highlighted).



Open Boiler Crown Valve (CV106) by clicking the Highlighted Button “CV106 Open”

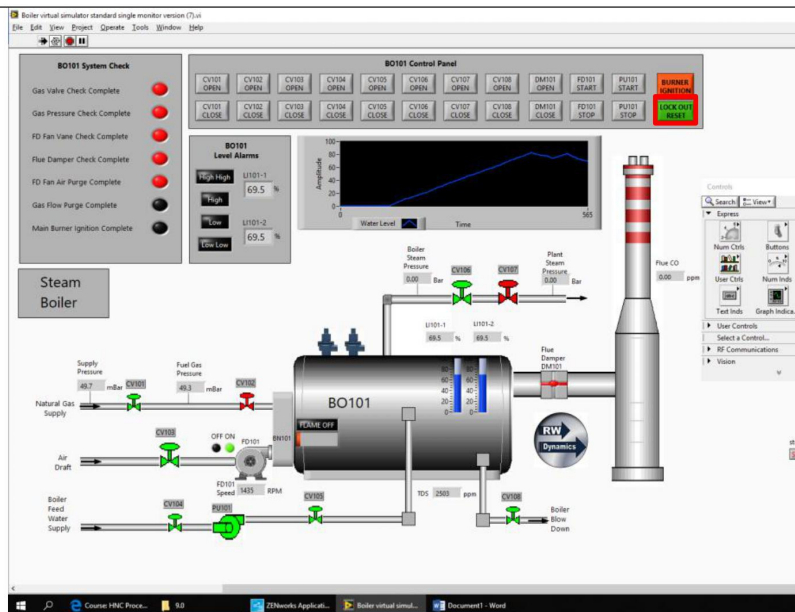




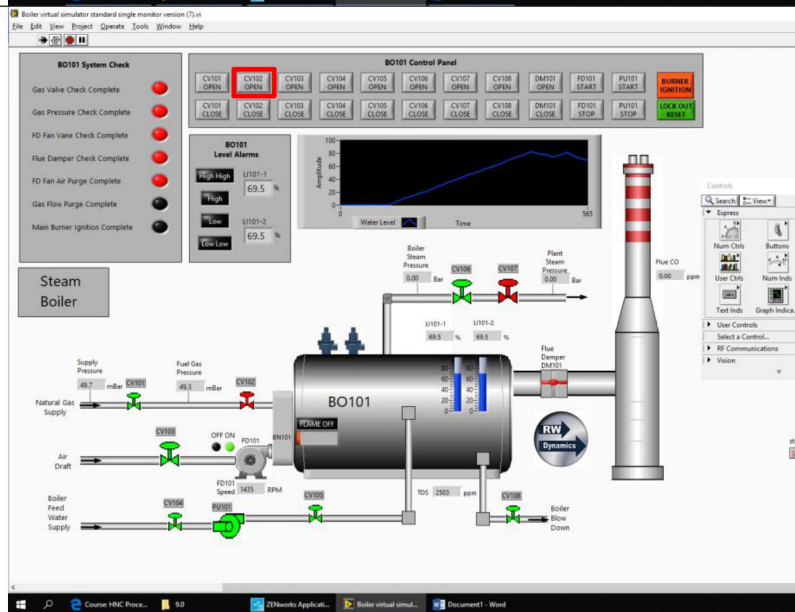
Start Up Procedure of BO101 Steam Boiler Plant

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Reset Lock Out Alarm by clicking the Highlighted Button "Lock Out Reset"



Open Natural Gas Supply Outlet Valve (CV102) by clicking the Highlighted Button "CV102 Open"

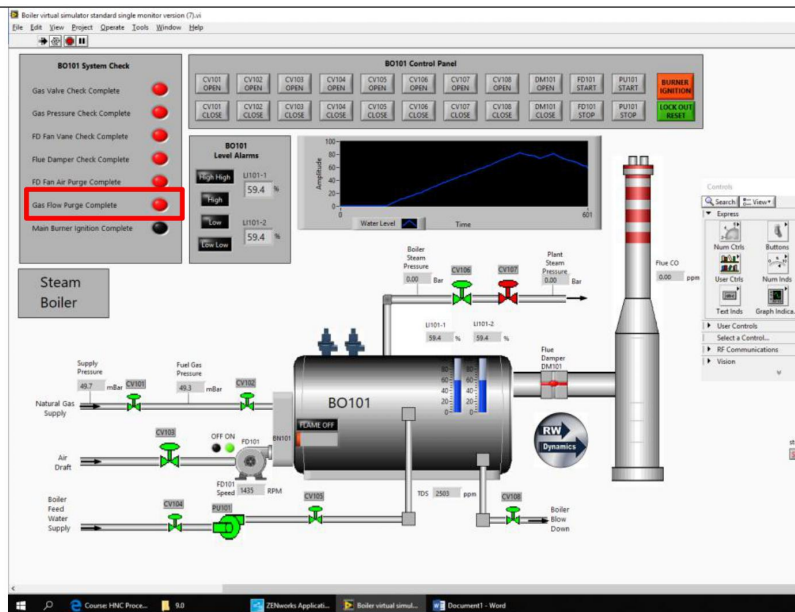




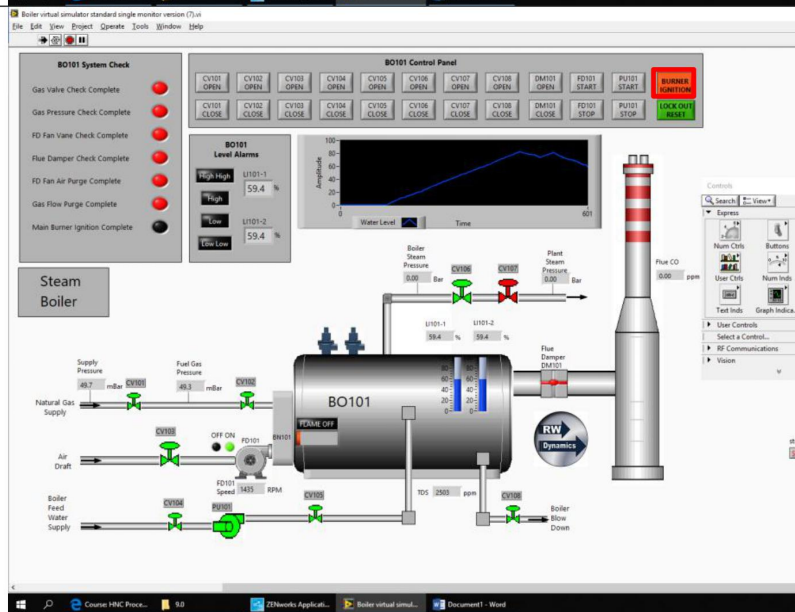
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Doing this will complete the “Gas Flow Purge” for the System Checks (Highlighted).



Ignite the Burner by clicking the Highlighted Button “Burner Ignition”

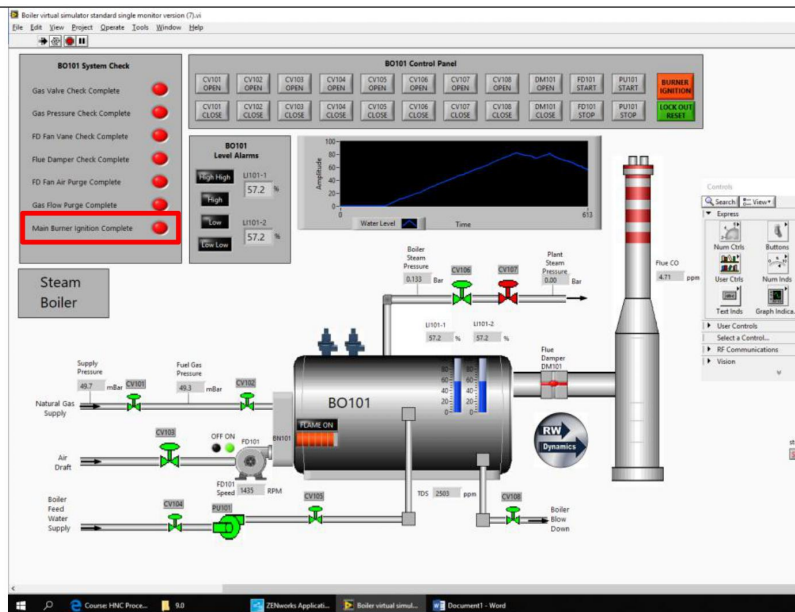




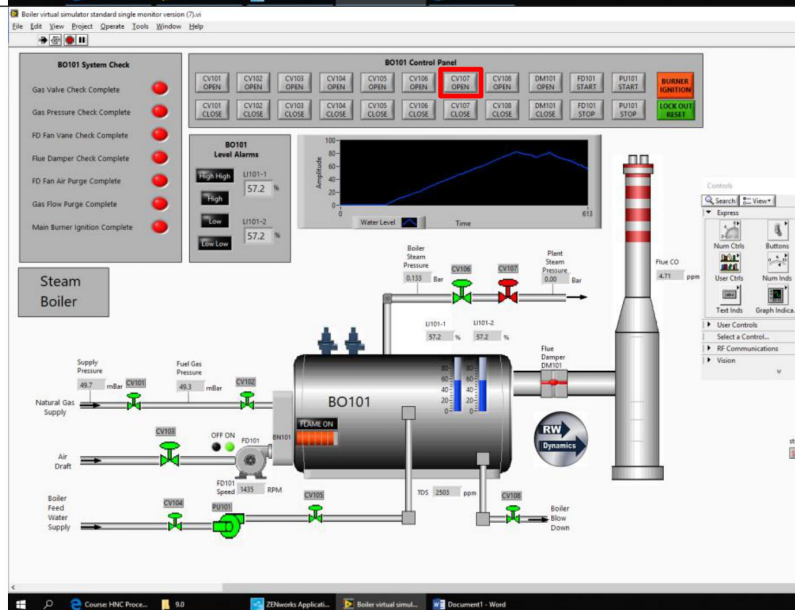
Start Up Procedure of BO101 Steam Boiler Plant

Document Number:	H-SOP-ENG-003
Version Number:	1
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Issuer:	M.Thomas
Authorised By:	N.Roberts
Location:	Haverfordwest
Document Type:	SOP

Doing this will complete the “Main Burner Ignition Check” for the System Checks (Highlighted).



Open Boiler Isolation Valve (CV107) by clicking the Highlighted Button “CV107 Open”

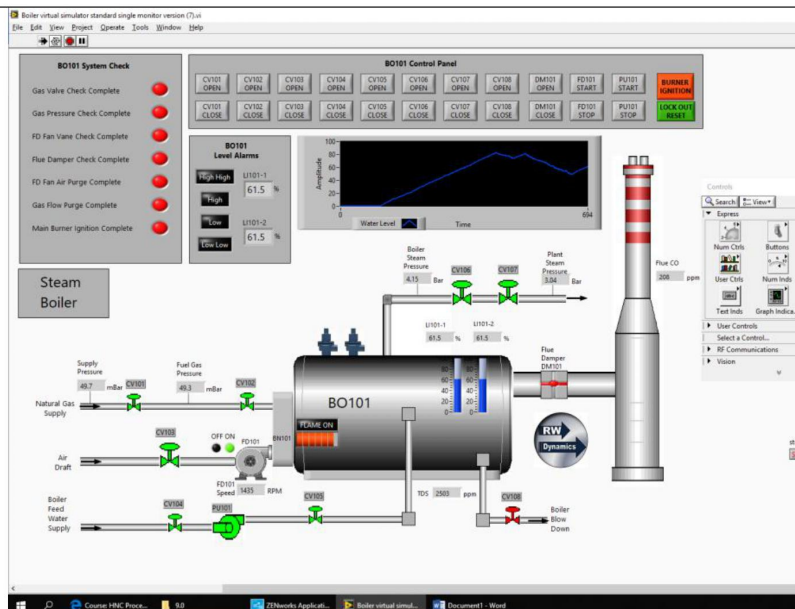




Start Up Procedure of BO101 Steam Boiler Plant

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Boiler is now online and supplying
Steam to Site



REFERENCE OR RELATED DOCUMENTS

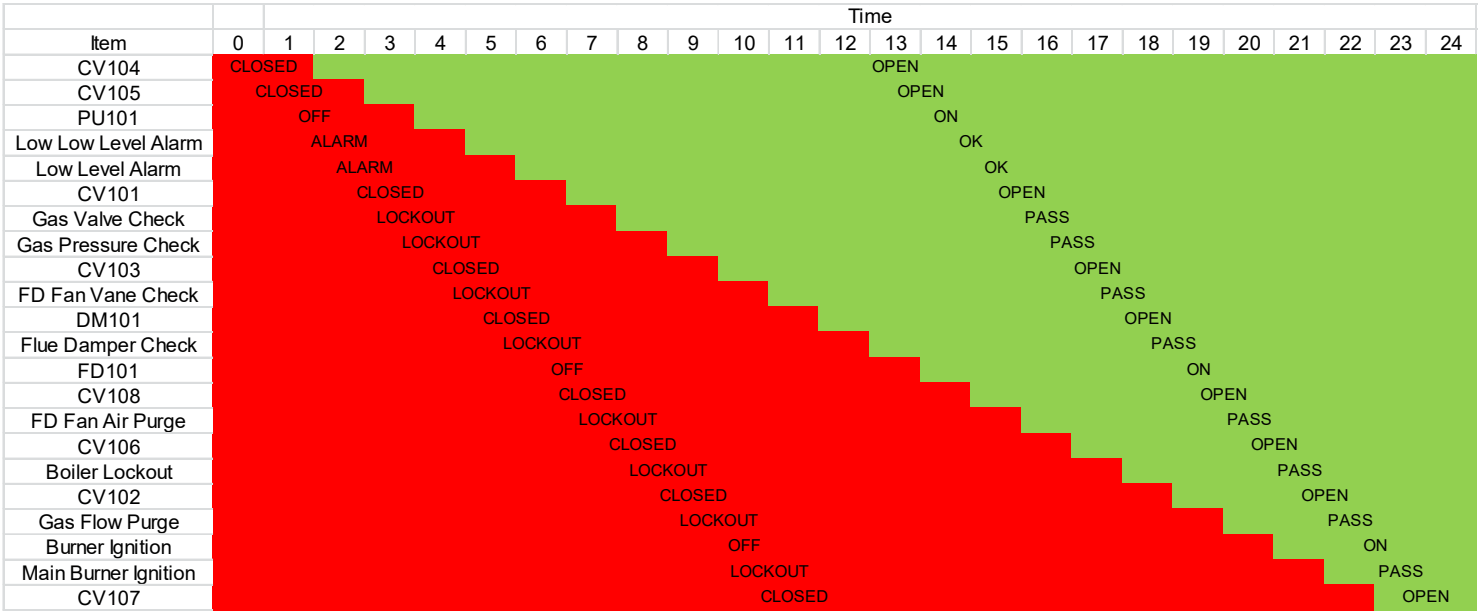
TRAINING REQUIRED

HISTORY OF AMENDMENTS

Version No.	Page/s	Section	Amendment Details	Amended By	Date

Timing Diagram

A Timing Diagram is a useful tool to visualise Processes. This can help in the understanding of the Process, especially for new Staff. The below is a Timing Diagram for the Process of starting up a Boiler.



It shows the order which steps are made and the before and after status of each item.

Alarm and Interlock Matrix

There are 4 Alarms and 7 Interlocks on this Boiler System.

The 4 Alarms are all in relation to the Water Level within the Boiler.

High High : This alarm activates if the Level of the Water within the Boiler goes above 85%.

High : This alarm activates if the Level of the Water within the Boiler goes above 80%.

Low : This alarm activates if the Level of the Water within the Boiler goes below 25%.

Low Low : This alarm activates if the Level of the Water within the Boiler goes below 10%.

There are 7 Interlocks on the System that must be completed before the Burner will ignite.

Gas Valve Check : This ensures that the First Gas Supply Valve (CV101) is operating correctly.

Gas Pressure Check : This ensures that the Pressure in the Gas Supply Line between Valves CV101 and CV102 is equal.

FD Fan Vane Check : This checks that the Burner is receiving air from Valve CV103.

Flue Damper Check : This check makes sure that the Flue Damper Valve (DM101) is open to allow Waste Gases to escape.

FD Fan Air Purge : When CV108 opens, this allows Impure Water to be removed from the System, thus allowing the system to Purge.

Gas Flow Purge : The Main Gas Supply Valve (CV102) opens purging the Gas Line to the Burner.

Main Burner Ignition : This checks that the Main Burner Ignites, thus allowing the full Steam Generation Process to begin.



References

Spirax Sarco, September 2019, *Steam Fundamentals Handbook Issue 8*, Spirax Sarco Group,

Learner Name : Matthew Thomas.

Course : HNC Process Operations Engineering, Year 1.

Module Code : PCPO4004.

Module Name : Industrial Process Operations and Control.

Task 3 : Bottle Filling Plant

Contents Page

Section	Page
Task 3 : Bottle Filling Plant	40
Contents Page	41
Introduction	42
Overview of Bottling Plant Process	43
Bottling Plant Process Flow Diagram	45

Introduction

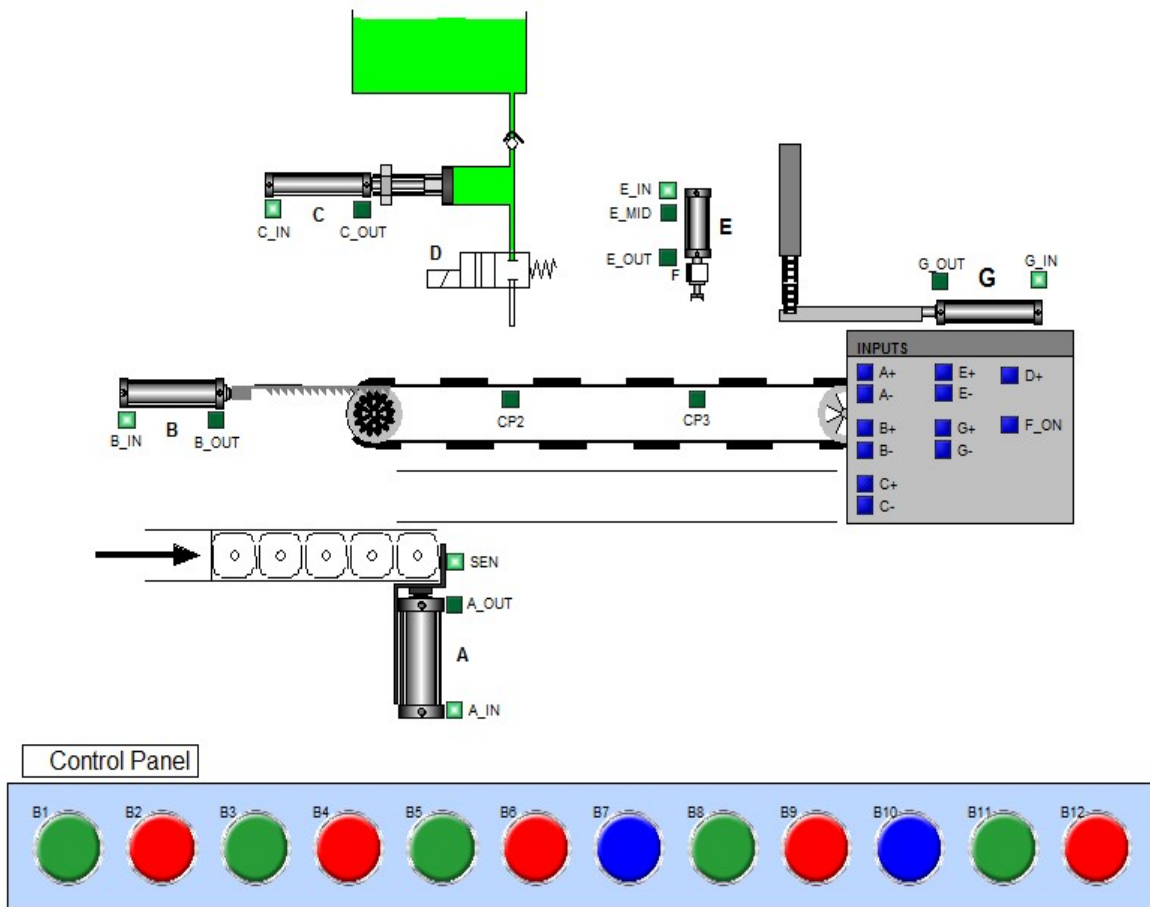
For this section of the Assignment, 2 tasks will be completed.

First there will be a brief overview of a Bottle Plant and it's method of working.

The second part will be a Process Flow Diagram of this same Bottle Plant.

Bottling Plant Process Overview

Below is a Screenshot of a Bottling Plant SCADA



This system is made up of :

A Conveyor System, driven by a Piston, Labelled as B.

A Bottle Feeder, driven by a Piston, Labelled as A.

A Bottle Filler System, consisting of a Feed Tank with a Valve, a Small Dosing System, a Piston used to push the Liquid from the Small Dosing System into the Bottle, Labelled as C, and a Valve to dispense the Liquid.

A Bottle Capper System, consisting of 2 Pistons, Labelled E and G, one of which (Piston G) pushes a Bottle Cap from their Feeder onto the other Piston (Piston E) that will push it onto the Bottle and turn it to tighten.

The System is designed to be operated from a number of On Screen Buttons. Each perform a Task that allow the smooth operation of Filling and Capping a Bottle.

Button B1 extends Piston A to allow a Bottle to be placed onto the Conveyor System.

Button B2 returns Piston A ready to move another Bottle onto the Conveyor.

Button B3 extends Piston B which moves the Conveyor forward one position.

Button B4 returns Piston B to allow it to move the Conveyor again.

Button B5 closes the Valve on the Liquid Feeder Tank so as to not flood the Bottle Dosing System when filling.

Button B6 returns Piston C and opens the Valve on the Liquid Feeder Tank allowing the Small Dosing System to refill.

Button B7 opens Valve D and extends Piston C pushing the Liquid from the Dosing System into the Bottle. Releasing this Button closed Valve D.

Button B8 extends Piston E to push a Bottle Cap onto a Bottle.

Button B9 returns Piston E away from the Bottle.

Button B10 rotates the Bearing on Piston E to allow the Bottle Cap to be tightened.

Button B11 extends Piston G moving a Bottle Cap from its Feeder into position on Piston E to be pushed onto a Bottle.

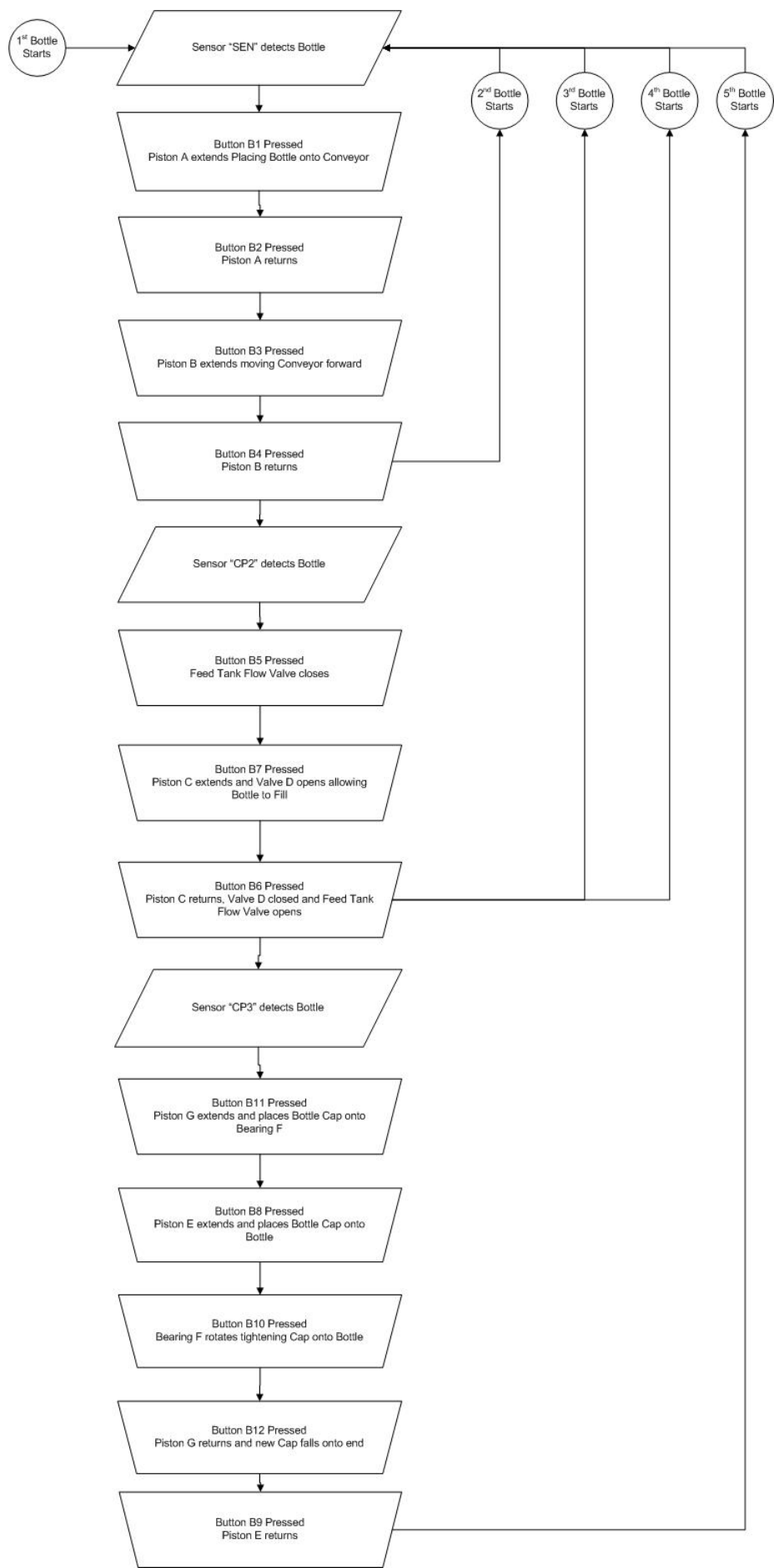
Button B12 returns Piston G and collects a new Bottle Cap.

The arrangement of the Buttons is not correct for the operation of the Bottle Plant, as is shown in the Flow Diagram in the “Bottling Plant Process Flow Diagram” section of this Assignment.

The operation of this Plan consists of moving an empty Bottle from its feeder and onto a Conveyor System. The system moves forward one step. At this time another bottle can be loaded onto the Conveyor. The first Bottle has arrived at the Filling Station. Here the Liquid is fed into a small Dosing System from a larger Feed Tank. The Liquid is dosed from here into the Bottle. The Bottle then moves forward 2 positions on the Conveyor into the Capping Station. Here a Bottle Cap is taken from its feeder and lowered onto the Bottle and tightened. The Bottle then moves forward on the Conveyor and onto another section of plant. At each movement of the Conveyor, another Bottle can be fed onto it, thus making the Operation continuous.



Bottling Plant Process Flow Diagram



Learner Name : Matthew Thomas.

Course : HNC Process Operations Engineering, Year 1.

Module Code : PCPO4004.

Module Name : Industrial Process Operations and Control.

Task 4 : SCADA (Supervisory Control and Data Acquisition)

Contents Page

Section	Page
Task 4 : SCADA (Supervisory Control and Data Acquisition)	46
Contents Page	47
Introduction	48
SCADA Report	49
References	50

Introduction

For this final part of the Assignment, a Report into SCADA Systems will be completed. It will what a SCADA is, what it does and where it is useful.

SCADA Report

A SCADA, or Supervisory Control and Data Acquisition, System is a Computer Program designed to automate many of the tasks required across industry. This could be something as simple as displaying data on a screen to an Operator, or could be much more complex and adjust plant or tasks based on this data. Many industries are switching to SCADA Systems as it allows them greater control of their Processes. Using a properly set up SCADA System will mean that a single Operator could control a whole Plant from a Control Room with only minimal time, if any, spent on the Plant. All of the Data from the Plant would be displayed on a Screen called a HMI, or a Human Machine Interface, for the Operator to view and changes or adjustments could be made on the same Screen which the Plant would then follow. An example of this in The First Milk Cheese Company Ltd would be for the new Milk Pasteurisation Room. This Room has very little Operator presence in it and is instead controlled from a different Area of the Factory. Data such as Milk Temperature and Milk Pasteuriser Pressures can be read from the SCADA HMI and adjustments can be made if needed.



A SCADA System could also remove the need for an Operator on some or even all Tasks. A SCADA will have set parameters to follow and it could automatically adjust the Plant if Data is showing that these parameters are not being met. This is something that is used within the Milk Pasteurisation Room in The First Milk Cheese Company Ltd. Should the Temperature of the Pasteurised Milk drop below its set point, the SCADA will automatically tell the System to Divert the Milk back to be re-Pasteurised. Due to the importance of this Process being performed correctly, the Operator must physically reset the System at the Plant. But it would be entirely possible for the SCADA to reset itself once the correct Temperature was reached and continue on with the Production run.

In order to collect this Data, the SCADA makes use of PLCs, or Programmable Logic Controllers. A PLC is a Controller (sometimes a single Card though sometimes a Panel) that can make a number of decisions much like the SCADA, but these are programmed into the Unit and are only useable on that single Unit. A SCADA and PLC communicate with each other and can work in tandem to control the Plant. The PLC will make minor adjustments to its plant in response to feedback either from the SCADA or from its own Data Collection. A SCADA can communicate with several PLCs and make adjustments all across the Process Line based on information from one or many of these PLCs. All of this information can be monitored and reviewed by an Operator anywhere.

Whilst not used at The First Milk Cheese Company Ltd, it would be entirely possible for Operators of the Haverfordwest Site to control Plant at the Lake District Site, should a Multi-Site SCADA System be set up. They would be able to view all Information as they do the Haverfordwest Plant and make adjustments as required. However when making Food, items must be checked and double checked, so doing this from a different Site would be a High Risk exercise.

References

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Kevin Cope, 2018, What is the Different between SCADA and HMI?, RealPars Website, April 2020, <
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Word Count : 2,117